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Indian Standard

IS 11977 : 2022

केले को पकाने के लिए मार्गदर्शिका

(पहला पुनरीक्षण)

Guide for Ripening of Bananas

(First Revision)

ICS 67.080.10

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fruits, Vegetables and Allied Products Sectional Committee had been approved by the Food and Agriculture Division Council.

Banana (*Musa* spp.) is an important fruit crop in India. The fruits are very hard when harvested at mature green stage but are highly perishable when they are ripened. Bananas continue to develop physiologically after they have been harvested, and their state of ripeness when they are placed in the ripening room will depend on their state when harvested and on different conditions to which they have subsequently been submitted.

Uniform ripening of banana hands with yellow surface colour is essential for proper marketing of banana. Commercial cultivars of banana belong to different genomic groups. For example, the AAA group bananas (Dwarf Cavendish, Robustaa, Grand Naine, etc.) require low temperature during ripening to develop into attractive yellow surface colour. Otherwise at higher temperatures the surface colour development will be either greenish yellow or yellowish green in the bananas belonging to this group. However, AAB (Poovan, Rasthali, Nendran), ABB (Karpooravalli) or AB (Ney Poovan) group bananas develop yellow peel colour after ripening, irrespective of the temperature.

This standard was first published in 1987 by adopting ISO 3959 : 1977, Green bananas — Ripening conditions, identically under dual number system. The first revision of this standard is being brought out to align the conditions of ripening of bananas with those prevailing in Indian scenario. Considerable assistance has been derived from the work carried out at ICAR-Indian Institute of Horticultural Research, Bengaluru.

This Indian Standard provides guidance on ripening of bananas, however, because of the variability of the product according to the time and place of cultivation, local conditions may make it necessary to define other conditions for ripening of bananas.

The composition of the Committee responsible for the formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’.

Indian Standard

GUIDE FOR RIPENING OF BANANAS

(First Revision)

1 SCOPE

1.1 This standard describes about optimum conditions for ripening of important varieties of banana belonging to different genome groups.

1.2 The guidelines apply to mature green bananas of different cultivars, namely Grand Naine, Dwarf Cavendish Robusta, Ney Poovan (Elakki Bale) Poovan, Rasthali, Karpooravalli, Nendran.

2 CONDITIONS FOR RIPENING

2.1 Harvesting and Maturity for Ripening

Bananas are harvested at mature light green stage and the maturity can be judged by degree of fullness of the fingers that is, disappearance of angularity. As the fruit matures on the plant, the fingers become less angular and more round. However, bananas harvested even at 85-90 percent maturity can be ripened to good quality with artificial ripening.

2.2 Pre-ripening Operations

2.2.1 *De-handing*

In this operation the banana hands are cut-off from the central peduncle/stem of the bunch. Though the harvested bunches can directly be placed in the ripening room, it is highly preferred to de-hand them before ripening. De-handing should be carried out with a sharp, clean, curved banana knife, making a smooth cut close to the stem. Care is required when de-handing to prevent fruit damage by the knife. Banana hands should not be handled by lifting with one or two central or end fingers which may cause finger breakage and will cause pedicel bruising that can lead to problems during ripening. Dirty or blunt knives will increase the levels of crown disease development and trimming the crown close to the fingers will result in crown breakage. Knife has to be dipped in antiseptic solution ($KMnO_4$) frequently.

2.2.2 *De-latexing*

After de-handing, the fruit should be placed with the crown facing downwards onto a layer of leaves to allow for latex drainage.

2.3 Ripening

Mature bananas left to ripen naturally will eventually soften but the change in colour will not be uniform and the peel will be dull, pale yellow and unattractive. Further, natural ripening in banana (especially Cavendish type) is a slow process that leads to more weight loss, desiccation of fruits and uneven ripening. In order to attain a bright uniform yellow peel colour, a firm pulp texture and good flavour, bananas are ripened artificially. The artificial ripening of fruits has also become essential in order to regulate the supply chain in the markets. Artificial ripening of banana is a necessity during their commercial handling and is a standard practice all over the world. In india, only ethylene gas is permitted for artificial ripening of any type of fruits.

2.4 Optimum Conditions for Ripening

Bananas are commercially ripened by exposing the fruits to ethylene gas (100 ppm) in the airtight rooms/ripening chambers for 18-24 h. Optimum temperature for ripening is around 20 °C with a relative humidity of 80-90 percent. Where humidity is too low, the weight loss will be more because of more moisture loss. Room ventilation after gassing with ethylene is essential to prevent the built up CO_2 (carbon dioxide) concentration released by the fruits so as to avoid its bad effects. The chamber temperature is maintained at 18-2 °C till green tip stage or stage 4 (Refer **4**). At this stage the fruits are sent to market which would ripen to bright yellow colour in another 2 days. After ripening to bright yellow stage it would have a yellow life of 1-3 days depending on the holding temperature.

NOTE — When the external ambient temperature is below 12 ºC in temperate regions, it is necessary to protect the bananas from chilling injury, by maintaining the temperature above 12 ºC in the ripening rooms using appropriate heating system.

3 USE OF ETHYLENE GAS FOR RIPENING

3.1 Sources of Ethylene Gas

Ethylene gas obtained through the following systems may be used for ripening of banana in the ripening chambers.

FIG.1 BANANA RIPENED WITH ETHYLENE GAS

3.1.1 *Ethylene Gas Cylinders*

Ethylene gas is available in large steel cylinders where it is kept under pressure. As it is highly flammable, the use of pure gas is discouraged and is usually diluted with nitrogen or other inert gases. Typical mixtures are 95 percent nitrogen and 5 percent ethylene or 90 percent nitrogen and 10 percent ethylene.

3.1.2 *Ethylene Generator*

This is a portable device, which is placed inside the ripening room. An ethylene releasing liquid is filled into the tank fitted with ethylene generator and it is connected to an electric power source. The liquid gets heated in a controlled manner in the presence of a catalyst and produces ethylene gas.

3.1.3 *Ethylene Gas Cans*

These are small tin canisters filled with ethylene gas and available in different sizes and capacities. They usually contain 5 percent ethylene and balance nitrogen gas. The gas can be sprayed into the chamber in required quantities.

3.1.4 *Ethylene Gas from Liquid 2- Chloroethyl Phosphonic Acid*

In this ethylene gas can be cheaply produced by the user itself by taking calculated quantity of liquid and adding required quantity of alkali (sodium hydroxide). As standardized at ICAR-IIHR, 2 ml of liquid is required for every 1 cubic meter of room size (when at least 3/4 volume of room is filled with fruits) and 1/4th gram of sodium hydroxide is needed per every ml of liquid used to liberate the ethylene gas in the chamber.

3.2 Method of Using Ethylene

Banana hands should be neatly placed in ventilated plastic crates and staked in the ripening chamber. Maintain the temperature and RH as mentioned above. Ethylene gas from any of the above source may be introduced directly into the ripening room and maintained at a concentration of 100 ppm. The quantity of gas introduced should be controlled using appropriate sensor mechanisms and circulation of the air is essential to spread the ethylene gas uniformly in the ripening room. After the introduction of the ethylene, the room should remain closed for a period of 24 h. After this period the ripening chamber is ventilated to remove the built up carbon dioxide and the chamber temperature is maintained dependent upon the variety. As mentioned earlier, the temperature controlled ripening is essential only in case of Cavendish bananas, particularly for colour development, while all other varieties ripe with ethylene under normal atmospheric temperature. However, ripening of banana under controlled temperature and humidity levels will certainly help to prevent moisture loss during ripening irrespective of the variety.

Thus the essential requirements of an effective ethylene ripening system are:

a) A reasonably airtight room with insulation;
b) A temperature control system for cooling and/or heating;
c) Humidity control;
d) An air circulation and ventilation system;
e) An ethylene gas injection system; and
f) Ethylene (C_2H_4) and carbon di-oxide (CO_2) gas sensors with control systems.

FIG. 2 RIPENING CHAMBER WITH ETHYLENE GAS AND TEMPERATURE CONTROL

Depending upon temperature of room where bananas are placed after ethylene gas exposure, it may take 4 to 10 days for completion of ripening process, lower the temperature of ripening longer the duration. The lowest temperature that can be used for ripening or storage of banana after ripening is 13 °C.

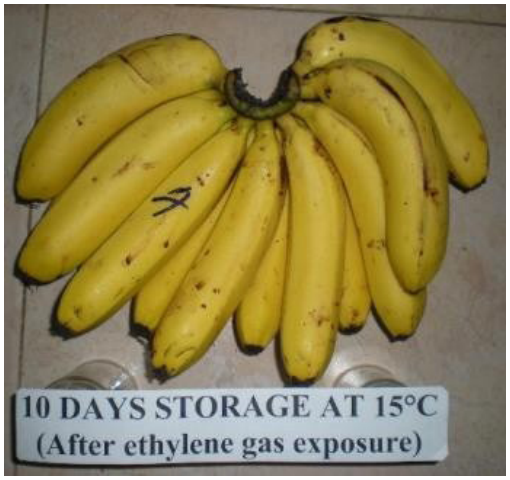

FIG. 3 BANANAS EXPOSED TO ETHYLENE GAS AND KEPT AT 15 °C

4 RIPENESS STAGES FOR SUPPLY TO RETAILERS

Table 1 explains about different stages of banana ripening based on the surface colour development**.** The degree of ripeness of bananas which are supplied to the retail trade should depend on the season and the temperature conditions in the retail shop. In summer, the bananas should be supplied at the stage when they are turning yellow (yellowish green). In cold weather, the bananas should be supplied with a more marked yellow colour than in summer (yellow, with green tips).

5 CAUSES OF DEFECTIVE RIPENING OF BANANAS

Table 2 gives the principal factors which are responsible for the defective ripening of bananas. Maturity harvest, rough handling that causes mechanical injuries, too low and too high temperature in ripening rooms and concentration of ethylene gas are the factors to be considered to avoid the ripening defects.

Table 1 Stages of Banana Ripening

(*Clause* 4)

Stages/Degree of Ripeness	Appearance of Skin	Characteristics
1	Green	Mature green colour at time of loading
2	Green with faint hint of yellow	First change in colour as a result of ripening
3	More green than yellow	Initial de-greening of skin indicates continuing ripening process
4	More yellow than green	Correct degree of ripeness for wholesalers to supply to retailers and delivery from ripening rooms
5	Yellow with green tip	Best condition for retail sale, as the fruit can still be kept for a few days
6	Completely yellow	Fruit appears at its best and is very tasty. When the fruit is this ripe, the skin is very sensitive to mechanical influences
7	Yellow with brown spots	Small brown spots (anthracnose spots known as sugar spots) indicate that the fruit is fully ripe. Its aroma and flavor are at their best

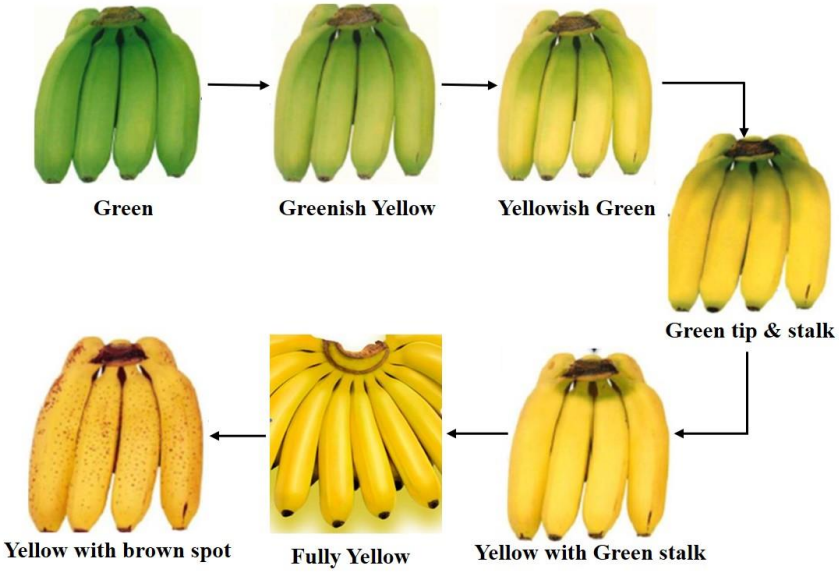

FIG. 4 VARIOUS STAGES OF BANANA RIPENING

Table 2 Causes of Defective Ripening

(*Clause* 5)

i)	Uneven ripening	Bananas with uneven degrees of maturity
ii)	Ripening too slowly	Immature initial fruits Temperature too low in the ripening room Gas leak in chamber or very low concentration of ethylene
iii)	Defective colour	Too low or too high temperature in ripening room Too high accumulated carbon-dioxide gas
iv)	Flesh soft and skin blackening	Too high a temperature Mechanical injuries during or after harvesting
v)	Development of rotting	Injuries due to rough handling Defective de-handling Insufficient disinfection of the ripening room
vi)	Finger dropping from hands	Too high concentration of ethylene gas Overexposure time to ethylene

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Fruits, Vegetables, and Allied Products Sectional Committee, FAD 10

Organization	*Representative(s)*
ICAR-Indian Institute of Horticultural Research, Bengaluru	Dr M. R. Dinesh (***Chairman***)
All India Food Processors Association, New Delhi	Dr R. K. Bansal Ms Mamta Arora (*Alternate*)
Association of Food Scientists and Technologists India, Mumbai	Dr Revathy Baskaran Dr K. V. Harish Prashanth (*Alternate*)
CSIR-Central Food Technological Research Institute, Mysore	Dr P. Vijayanand Dr A. S. Chauhan (*Alternate*)
College of Agricultural Engineering Post-Harvest Technology, Gangtok	Dr Sujata Jena Dr Said Prashant Pandharinath (*Alternate*)
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Consumer Guidance Society of India, Mumbai	Dr Sitaram Dixit Dr M. S. Kamath (*Alternate*)
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ICAR-Indian Institute of Horticultural Research, Bengaluru	Dr R. B. Tiwari Dr D. V. Sudhakar Rao (*Alternate*)
ICAR-Central Institute for Subtropical Horticulture, Lucknow	Dr Neelima Garg
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Member Secretary

Shrimati Varsha Gupta
Scientist 'D' (FAD), BIS

Review of Indian Standards Related to Storage, Transport and Ripening of Fresh Fruits and Vegetables, FAD 10 : Panel 2

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ICAR-Indian Institute of Horticulture Research, Bengaluru	Dr D. V. Sudhakar Rao
ICAR-Central Institute for Subtropical Horticulture, Lucknow	Dr Bharati Killadi
Warehousing Development and Regulatory Authority, New Delhi	Shri Vinay Kumar Chauhan

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amend No.	Date of Issue	Text Affected

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